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TRANSMITTAL

Electronic Version v1.1

Stylesheet Version v1.1.0

Title of Invention	VACUUM CLEANER WITH CYCLONIC DIRT SEPARATION AND BOTTOM DISCHARGE DIRT CUP WITH FILTER

Application Number :

Date :

First Named Applicant: Joseph A. Fester

Confirmation Number:

Attorney Docket Number: 71189-1532

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Documents being submitted:	Files
us-request	71189-1532-usrequ.xml
	us-request.dtd
	us-request.xsl
us-fee-sheet	71189-1532-usfees.xml
	us-fee-sheet.xsl
	us-fee-sheet.dtd
application-body	Specification-trans.xml
	us-application-body.xsl
	application-body.dtd
	wipo.ent
	mathml2.dtd
	mathml2-qname-1.mod
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	isopub.ent
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	soextblx.dtd
	Figure_1.tif
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	Figure_3.tif
	Figure_4.tif
	Figure_5.tif
	Figure_6.tif
Comments	

APPLICATION DATA SHEET

Electronic Version v14

Stylesheet Version v14.0

Title of Invention	VACUUM CLEANER WITH CYCLONIC DIRT SEPARATION AND BOTTOM DISCHARGE DIRT CUP WITH FILTER

Application Type : provisional, utility

Attorney Docket Number : 71189-1532

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Description

VACUUM CLEANER WITH CYCLONIC DIRT SEPARATION AND BOTTOM DISCHARGE DIRT CUP WITH FILTER

BACKGROUND OF INVENTION

FIELD OF THE INVENTION

[0001] The invention relates to suction cleaners, and in particular to a separator for a suction cleaner. In one of its aspects, the invention relates to a separator with a cyclonic airflow path to separate dirt and debris from air drawn into the cleaner. In another of its aspects, the invention relates to a separator that deposits the dirt and debris in a collection receptacle. In another of its aspects, the invention relates to a bottom discharge dirt cup with an integrated filter chamber. In another of its aspects, the invention relates to a separator including structure for inhibiting the re-entrainment of debris that vacillates with upward airflows in the collection receptacle.

DESCRIPTION OF THE RELATED ART

[0002] Cyclone separators are well known. Some follow the text-book examples using frusto-conical shape separators and others use high-speed rotational motion of the air/dirt to separate the dirt by centrifugal force. Typically, working air enters and exits at an upper portion of the cyclone separator as the bottom portion of the cyclone separator is used to collect debris. Furthermore, in an effort to reduce weight, the motor/fan assembly that creates the working air flow is typically placed at the bottom of the handle, below the cyclone separator. This arrangement therefore, requires a tortuous air path from the top of the cyclone assembly, down the handle to the inlet of the motor/fan assembly. This creates a long air path with multiple parts which may allow for air leaks and generally negatively impacting airflow and, necessarily, cleaning performance.

[0003] Conrad et al., in U.S. Patent No. 6,129,775 discloses a cyclone separator with at terminal insert which can take a number of forms. In FIG. 14(d), the terminal insert may comprise a plurality of longitudinally extending members (such as rods), which extend upwardly into the cyclone separator cavity from the bottom surface of the cyclone

separator. The rods are said to interact with circulating fluid 48 to disrupt its rotational motion. The rods may be positioned symmetrically non-symmetrically around longitudinal axis of the separator. The rods may be a variety of shapes such as, in transverse section, squares, ellipses or other closed convex or abode shapes. Further, the transverse section of rods may vary longitudinally.

[0004] BISSELL Homecare, Inc. presently manufactures and sells in the United States an upright vacuum cleaner that has a cyclone separator and a dirt cup. A horizontal plate separates the cyclone separator from the dirt cup. The air flowing through the cyclone separator passes through an annular cylindrical cage with baffles and through a cylindrical filter before exiting the cyclone separator at the upper end thereof. The dirt cup has three finger-like projections extending upwardly from the bottom thereof to agglomerate the dirt in the dirt cup. The dirt cup further has a pair of radial fins extending inwardly from the side walls of the dirt cup. The dirt cup and the cyclone separator is further disclosed in the co-pending U.S. Patent Application, S.N. 10/058,514, filed January 28, 2002, which application is incorporated herein by reference.

[0005] U.S. Patent No. 6,070,291 to Bair et al. and its progeny at-

tempts to solve the efficiency problem by shortening the air path from the cyclone exhaust to the motor inlet. These patents disclose a pleated main filter element in a cyclonic chamber whereby exhaust air is drawn through the main filter through the bottom of the cyclonic chamber and directly into the motor/fan inlet. The motor/fan assembly is in a vertical position below the cyclone which is undesirable due to the amount of space needed at the bottom of the handle.

[0006] U.S. Patent No. 6,341,404 to Salo et al. discloses a bottom discharge cyclone chamber with the motor/fan assembly mounted horizontally below the cyclone chamber. However, motor exhaust air is redirected back up towards the bottom of the cyclone chamber where it exits the unit in a radial fashion. This path introduces a number of turns which tends to create backpressure and therefore reduce efficiency.

SUMMARY OF INVENTION

[0007] According to the invention, a vacuum cleaner comprises a housing defining a cyclonic airflow chamber for separating contaminants from a dirt-containing air stream and a cyclonic chamber inlet and an air stream outlet in fluid communication with said cyclonic airflow chamber. The

vacuum cleaner includes a nozzle base housing having a suction opening fluidly connected with the cyclonic chamber inlet, and an airstream suction source fluidly connected to the main suction opening and to the cyclonic airflow chamber for transporting dirt-containing air from the suction opening to the cyclonic airflow chamber. The suction source is adapted to establish and maintain a dirt-containing airstream from the suction opening to the cyclonic chamber inlet.

[0008] A dirt-collecting bin is mounted to the housing beneath the cyclonic airflow chamber and includes a bottom wall and a cylindrical sidewall. A separator plate between the cyclonic airflow chamber and the dirt-collecting bin separates the cyclonic airflow chamber from a the dirt-collecting bin. The separator plate has a diameter less than a diameter of the cyclonic airflow chamber adjacent the separator plate to thereby define a gap between the separator plate and the cyclonic airflow chamber for passage of dirt separated from the dirt-containing airstream in the cyclonic airflow chamber. The passage of dirt through the gap is accompanied by an elliptical airflow having horizontal and vertical components between the gap and the bottom wall of the dirt-collecting bin, which

elliptical airflow tends to entrain dirt particles therein. It is believed that this airflow may be elliptical in form.

[0009] The dirt collecting bin further comprises a centrally located vertical standpipe fluidly connected to the airstream outlet at an upper end and a dirt bin exhaust opening at the bottom end. A filter chamber is disposed beneath the bottom wall of the dirt collecting bin and is in fluid communication with the dirt bin exhaust opening. A filter assembly is positioned in the filter chamber. Filter chamber also has an outlet opening that is in fluid communication with the motor/fan inlet.

[0010] In one embodiment, the filter chamber is integral with the dirt collecting bin whereby both the dirt bin and filter assembly are selectively removable together from the housing.

[0011] In another embodiment, the filter chamber is separate from the dirt collecting bin and either may be selectively removed separately from the housing.

[0012] Airflow inhibitors are present in the dirt-collecting bin to reduce the vertical component of the elliptical airflow, thereby tending to agglomerate and separate the dirt particles from the elliptical airflow.

[0013] In one embodiment, the elliptical flow inhibitors comprise

at least one finger extending upwardly from the bottom wall of the dirt-collecting bin and positioned radially between a center of the dirt-collecting bin and the sidewall thereof. Preferably, the elliptical airflow inhibitors comprise a plurality of said fingers each positioned radially between a center of the dirt-collecting bin and the sidewall thereof. The fingers extend a portion of the distance from between the bottom wall and the separator plate. Further, the fingers are rectangular in cross section with a long axis radially disposed in the dirt-collecting bin.

[0014] In another embodiment, the elliptical airflow inhibitors further comprise at least one fin that extends radially inwardly from the sidewall of the dirt-collecting bin. Preferably, there are two and only two fins. The fins are generally positioned vertically below the inlet. The fin or fins extend a portion of the distance between the bottom wall and the separator plate. The fin or fins extend between 40% and 60% of the distance between the bottom wall and the separator plate. Generally, the fins have a radial dimension between 2% and 10% of the radius of the dirt-collecting bin, preferably between 3% and 6% of the radius of the dirt-collecting bin. In a specific embodiment, the fins have a radial dimension equal to about 4% of the ra-

dius of the dirt-collecting bin.

Brief Description of Drawings

[0015] In the drawings:

[0016] FIG. 1 is a perspective view of an upright vacuum cleaner with cyclone separator according to the invention.

[0017] FIG. 2 is a cut-away perspective view of the cyclonic separator of FIG. 1.

[0018] FIG. 3 is a cut-away exploded perspective view of the cyclonic separator of FIG. 1.

[0019] FIG. 4 is a front cross-sectional view of the cyclonic separator of FIGS. 1-2.

[0020] FIG. 5 is a cross-sectional view taken through line 5-5 of FIG. 4.

[0021] FIG. 6 is a cross-sectional view taken through line 6-6 of FIG. 4.

Detailed Description

[0022] An upright vacuum cleaner 10 with cyclonic dirt separator and dirt cup assembly 12 according to the invention is shown in FIG. 1, comprising an upright handle 14 pivotally mounted to a nozzle base 16. The upright handle 14 mounts the cyclonic dirt separator and dirt cup assembly 12 according to the invention.

[0023] Referring to FIG. 2, cyclonic dirt separator and dirt cup assembly 12 according to the invention comprises a cylindrical cyclone separator 18 having an upper wall 20 and a sidewall 22, the sidewall 22 terminating in a lower offset lip 24. An annular collar 26 depends from upper wall 20, the collar 26 being centered in the cylindrical cyclone separator 18. Sidewall 22 further includes a tangential air inlet 28 aligned proximate the upper wall 20 for generating a tangential airflow in the separator 18 parallel to the upper wall 20.

[0024] The cyclonic dirt separator 18 further comprises an exhaust assembly 30. The exhaust assembly 30 comprises a hollow cylindrical louver cage 32 mounted on a separator plate 34. Louver cage 32 further comprises a plurality of louvers 36 cylindrically arranged between a top portion of the louver cage 32 and the separator plate 34. A working air path is defined through the louver cage 32 and through a centrally located aperture on the separator plate 34. The louver cage 32 and separator plate 34 are removably mounted on the annular collar 26 on the upper wall 20 of the cyclone separator 18 via a friction fit. However, other mechanical fastening means can be used to removably mount the exhaust assembly 30 to the upper wall 20.

For example, one quarter turn bayonet fasteners, ramped threads, detents, or any other commonly known fastening method can be used according to the invention.

[0025] Also in this manner, a toroidal chamber 48 is defined between the cylindrical arrangement of louvers 36 and the sidewall 22, and between the upper wall 20 and the separator plate 34, respectively. In the preferred embodiment, air inlet 28 is vertically aligned between upper wall 20 and separator plate 34 such that the tangential airflow generated from tangential air inlet 28 is directed into the toroidal chamber 48.

[0026] With further reference to FIGS. 2-6, the tangential airflow, containing particulate matter, passes through tangential air inlet 28 and into toroidal chamber 48 to travel around the exhaust assembly 30. As the airflow travels about the toroidal chamber 48, heavier dirt particles are forced toward sidewall 22. These particles fall under the force of gravity through a gap 50 defined between an edge 52 of separator plate 34 and the sidewall 22. Referring particularly to FIG. 4, dirt particles falling through the gap 50 drop through an open end of separator 18 and are collected in a dirt cup and filter chamber assembly 54. The upper end of dirt cup/filter chamber 54 is received in a

nesting relationship in lower offset lip 24 of the sidewall 22 to seal the cyclone separator 18 to the dirt cup/filter chamber 54. Dirt cup/filter chamber 54 thereby performs the function of collecting the dirt separated from the air-flow within the cyclone separator 18.

[0027] As the inlet air traverses through toroidal chamber 48, casting dirt particles toward sidewall 22, the inlet air will be drawn inwardly between louvers 36. As seen in FIG. 5, louvers 36 are oriented away from the direction of air flow (indicated by arrows) about toroidal chamber 48. The velocity of the air flow is altered as the air flow changes direction to pass around and between louvers 36. This change in the velocity of the air flow causes it to shed additional dirt particles. These dirt particles are urged toward the gap 50 by the circulating air flow in cyclone separator 18.

[0028] Referring now to the dirt cup/filter chamber 54 shown in FIGS. 2-5, dirt cup/filter chamber 54 comprises a pair of vertically oriented regions. The upper region comprises the dirt cup region 58 for collecting dirt as previously described and the lower chamber region comprises the filter chamber 60. Dirt cup region 58 is formed with a generally planar dirt cup bottom wall 62 and an upstanding cylin-

drical dirt cup sidewall 64 to form an open-topped receptacle. A plurality of upstanding prongs or fingers 66 project upwardly from bottom wall 62. The fingers 66 can function in varying arrangements, but in the preferred embodiment the fingers 66 are arranged generally symmetrically about a hollow standpipe 68 concentric with sidewall 64. Hollow standpipe 68 is fluidly connected to bottom of exhaust assembly 30 separator plate 34 at a top end and a centrally located aperture in the dirt cup bottom wall 62 at a bottom end. The fingers 66 are found to function best when displaced at least some distance from an outer wall of the standpipe 68. Each of the fingers 66 are shown as being generally rectangular in plan view, having a long axis of its plan cross-section aligned with a radius of the circle. The fingers 66 can be of uniform cross-section from top to bottom, or can have a tapering cross-section as depicted in FIG. 4, wherein the fingers 66 are narrower at the top and wider at the base where they join the bottom wall 62. The fingers 66, as shown in the FIGS. 2-4, are approximately one half the height of the dirt cup region 58. Increasing the height of fingers 66 is preferred, but can be limited by production and tooling constraints and, as will be further described, the need to

be able to detach dirt cup/filter chamber 54 from cyclone separator 18. In an alternate embodiment, fingers 66 can be attached to an outer surface of standpipe 68 and extend outward therefrom terminating at some distance from the outer side wall 64.

[0029] The dirt cup region 58 further includes a pair of fins 70, 72 affixed to and contiguous with sidewall 64. Fins 70, 72 are generally rectangular in cross-section, in plan view, projecting inwardly from sidewall 64 toward a center of dirt cup region 58. The distance fins 70, 72 project from sidewall 64 can range from 2 to 10% of the radius, but is preferably 3 to 6% of the radius, and optimally 4% of the radius of the dirt cup region 58. Fins 70, 72 extend generally upwardly from bottom wall 62 of dirt cup region 58. In the preferred embodiment, fins 70, 72 are perpendicular to bottom wall 62 and extend approximately one-half of the height of dirt cup region 58, although fins 70, 72 can vary in height from 40 to 60% of the distance from bottom wall 62 to separator plate 34 and still be effective. Also in the preferred embodiment, fins 70, 72 are generally aligned in the direction of inlet airflow entering cyclone separator 18 through air inlet 28. As shown in FIG. 2-4, fins 70, 72 are arranged with respect to a radial

plane 74 perpendicular to the tangential line that is in alignment with inlet 28, with fin 70 angularly displaced from radial 74 by angle α and fin 72 displaced from radial 74 by angle β. These angles can vary over a range of about 30° to 60°, and preferably in the range of 40° to 50°. It has been found that a satisfactory placement of the fins results when the angle α is about 45° and the angle β is about 45°.

[0030] A known phenomenon in cyclone separators is the re-entrainment of dirt into the cyclonic airflow after it is apparently deposited in a dirt containment vessel positioned beneath the cyclone chamber. It has been discovered that this re-entrainment is due to the vertical component of air circulation within the dirt cup between the gap 50 at one side of the dirt-colleting bin and the bottom wall 62 at an opposite side of the dirt-collecting bin. Generally, the airflow pattern has the strongest component at the bottom portion of the dirt-collecting bin 560 below the inlet 152 to the cyclone chamber 550. This air circulation is shown in phantom lines in FIG. 4.

[0031] These vertical components of the air circulation are manifested in the "vacillating" of the dirt deposited within the dirt cup region 58. Disruption of, or a decrease in the

magnitude of, these vertical components or vectors serves to minimize the re-entrainment of dirt in the cyclonic air-flow and agglomeration of the dirt in the dirt cup. Disruption of the airflow tends to agglomerate the dirt particles in the dirt cup region 58, forming clumps or balls unlikely to be re-entrained. It has been found that fingers 66 and fins 70, 72 function in concert to inhibit the vacillation of the debris deposited in dirt cup region 58, disrupting the elliptical vectors that generate upward currents that would tend to carry the smaller dirt particles upwardly and back into the cyclonic air flow. Fingers 66 further deflect dirt particles within the dirt cup region 58 to further encourage agglomeration of the dirt particles. Fingers 70, 72 are generally arranged symmetrically about dirt cup region 58, but have been found to cooperate with fins 70, 72 optimally when none of fingers 66 are directly aligned with either of fins 70, 72.

[0032] Referring to FIGS. 2-4, filter chamber region 60 further comprises a bottom wall 76 in spaced relation to the dirt cup bottom wall 62 and with a side wall 80. Bottom wall 62 further comprises a centrally located aperture that is in fluid communication with bottom portion of standpipe 68. Bottom wall 76 further comprises an aperture to remov-

ably receive a filter assembly 82. Filter assembly 82 further comprises a filter cage 84 which supports a cylindrical foam filter 86. Filter assembly mates with bottom wall 76 via a ¼ turn bayonet fastener or any other suitable mechanical fastening means as previously described. As can be appreciated, air flow enters the filter chamber region 60 from aperture in bottom wall 62, passes through foam filter 86 where particulate matter is captured, and continues on to the suction source inlet. Optionally, the suction source exhaust may pass through a final filter before re-entering the atmosphere.

[0033] Dirt cup/filter chamber 54 is removably connected to housing 12. Dirt cup/filter chamber 54 is generally vertically adjustable relative to cyclone separator 18, such as by a cam mechanism on a vacuum cleaner, so that it can be raised into an engaged and operative position underneath the cyclone separator 18. Upper edge of sidewall 64 is received within offset lip 24, which prevents dirt cup/filter chamber 54 from being dislodged from cyclone separator 18. To remove dirt cup/filter chamber from cyclone separator 18, such as to discard accumulated dirt, dirt cup/filter chamber is displaced downwardly from cyclone separator 18. Once disengaged from offset lip 24, dirt

cup/filter chamber 54 can be removed from separator 18.

[0034] While the invention has been specifically described in connection with certain specific embodiments thereof, it is to be understood that this is by way of illustration and not of limitation. Reasonable variation and modification are possible within the forgoing disclosure and drawings without departing from the spirit of the invention which is defined in the appended claims.

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Claims

[c1] A vacuum cleaner comprising:

a housing defining a cyclonic airflow chamber for separating contaminants from a dirt-containing airstream, said housing further comprising a cyclonic chamber inlet and an airstream outlet in fluid communication with said cyclonic airflow chamber;

a nozzle housing including a suction opening, said suction opening being fluidly connected with said cyclonic chamber inlet;

an airstream suction source fluidly connected to said main suction opening and to the cyclonic airflow chamber for transporting dirt-containing air from the main suction opening to the cyclonic airflow chamber, said suction source is adapted to establish and maintain a dirt-containing airstream from said main suction opening through said cyclonic airflow chamber inlet;

a dirt-collecting bin mounted to the housing beneath said cyclonic airflow chamber, the dirt-collecting bin comprising a bottom wall, a sidewall, and a centrally located hollow standpipe;

a separator plate between the cyclonic airflow chamber and the dirt-collecting bin and separating the cyclonic

airflow chamber from the dirt-collecting bin, the separator plate having a diameter less than a diameter of the cyclonic airflow chamber adjacent the separator plate to thereby define a gap between the separator plate and the cyclonic airflow chamber for passage of dirt separated from the dirt-containing airstream in the cyclonic airflow chamber; and a filter chamber located below the dirt collecting bin to remove fine particles from the airstream before reaching the suction source.

[c2] A vacuum cleaner according to claim 1 wherein the filter chamber is separate from the dirt collecting bin and either may be selectively removed separately from the housing.

[c3] A vacuum cleaner according to claim 1 wherein the filter chamber is integral with the dirt collecting bin whereby both the dirt bin and filter assembly are selectively removable together from the housing.

[c4] A vacuum cleaner according to claim 1 wherein the passage of dirt through the gap is accompanied by airflow patterns having horizontal and vertical components between the gap at one side of the dirt-collecting bin and the bottom wall at an opposite side of the dirt-collecting bin, which airflow tends to entrain dirt particles therein.

[c5] A vacuum cleaner according to claim 4 wherein airflow inhibitors are present in the dirt-collecting bin to reduce the vertical component of the airflow, thereby tending to agglomerate and separate the dirt particles from the airflow.

[c6] A vacuum cleaner according to claim 5 wherein the flow inhibitors comprise at least one finger extending upwardly from the bottom wall of the dirt-collecting bin and positioned radially between a center of the dirt-collecting bin and the sidewall thereof.

[c7] A vacuum cleaner according to claim 6 wherein the airflow inhibitors comprise a plurality of said fingers, each of which is positioned radially between a center of the dirt-collecting bin and the sidewall thereof.

[c8] A vacuum cleaner according to claim 7 wherein the fingers extend a portion of the distance between the bottom wall and the separator plate.

[c9] A vacuum cleaner according to claim 8 wherein the fingers are rectangular in cross section with a long axis radially disposed in the dirt-collecting bin.

[c10] A vacuum cleaner according to claim any of claims 4-8 wherein the airflow inhibitors further comprise at least one fin that extends radially inwardly from the sidewall

of the dirt-collecting bin.

[c11] A vacuum cleaner according to claim 10 wherein there are two and only two fins.

[c12] A vacuum cleaner according to claim 11 wherein the fins are generally positioned vertically below the inlet.

[c13] A vacuum cleaner according to any of claims 10-12 wherein the fin or fins extend a portion of the distance between the bottom wall and the separator plate.

[c14] A vacuum cleaner according to claim 13 wherein the fin or fins extend between 40% and 60% of the distance between the bottom wall and the separator plate.

[c15] A vacuum cleaner according to any of claims 10-14 wherein the fins have a radial dimension between 2% and 10% of the radius of the dirt-collecting bin.

[c16] A vacuum cleaner according to claim 15 wherein the fins have a radial dimension between 3% and 6% of the radius of the dirt-collecting bin.

[c17] A vacuum cleaner according to claim 15 wherein the fins have a radial dimension equal to about 4% of the radius of the dirt-collecting bin.

Electronic Version
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VACUUM CLEANER WITH CYCLONIC DIRT SEPARATION AND BOTTOM DISCHARGE DIRT CUP WITH FILTER

Abstract

A vacuum cleaner with cyclonic dirt separation and a bottom discharge dirt cup beneath the cyclone separator and a filter beneath the dirt cup and between the dirt cup and a suction motor inlet. A separator plate separates the cyclone separator from the dirt cup. Fins project from a sidewall of the dirt tank, and fingers projecting from a bottom wall of the dirt tank. A hollow standpipe in the dirt cup transports working air from the cyclone separator outlet to the filter.

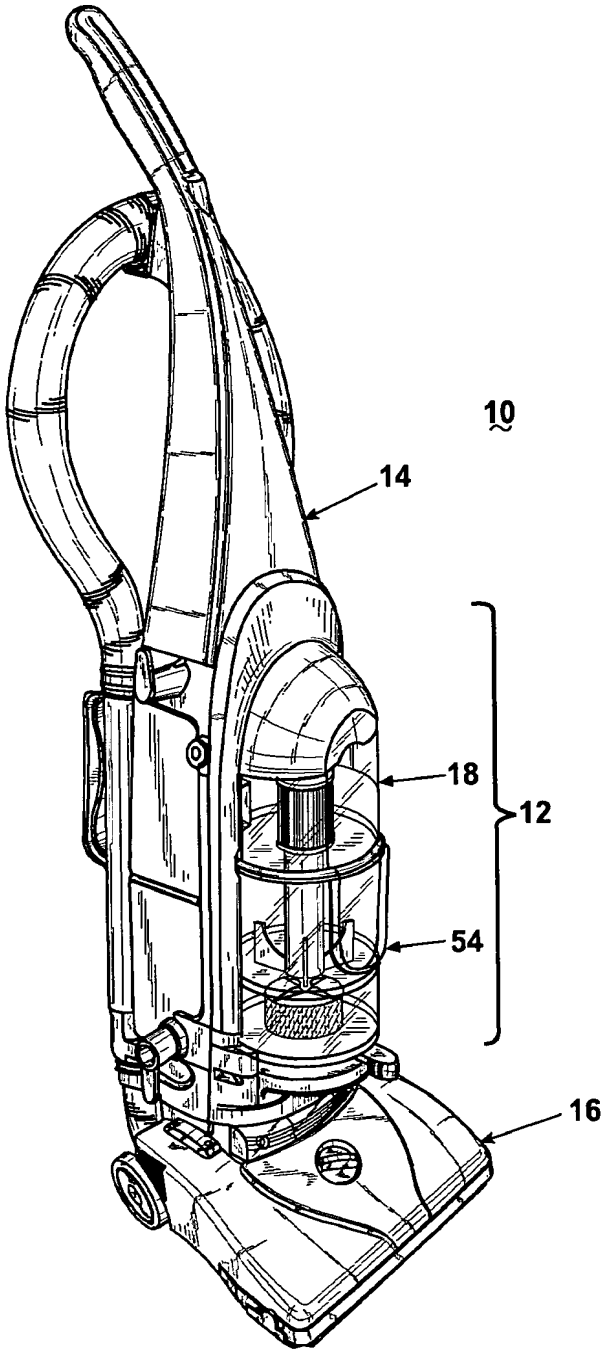

Fig. 1

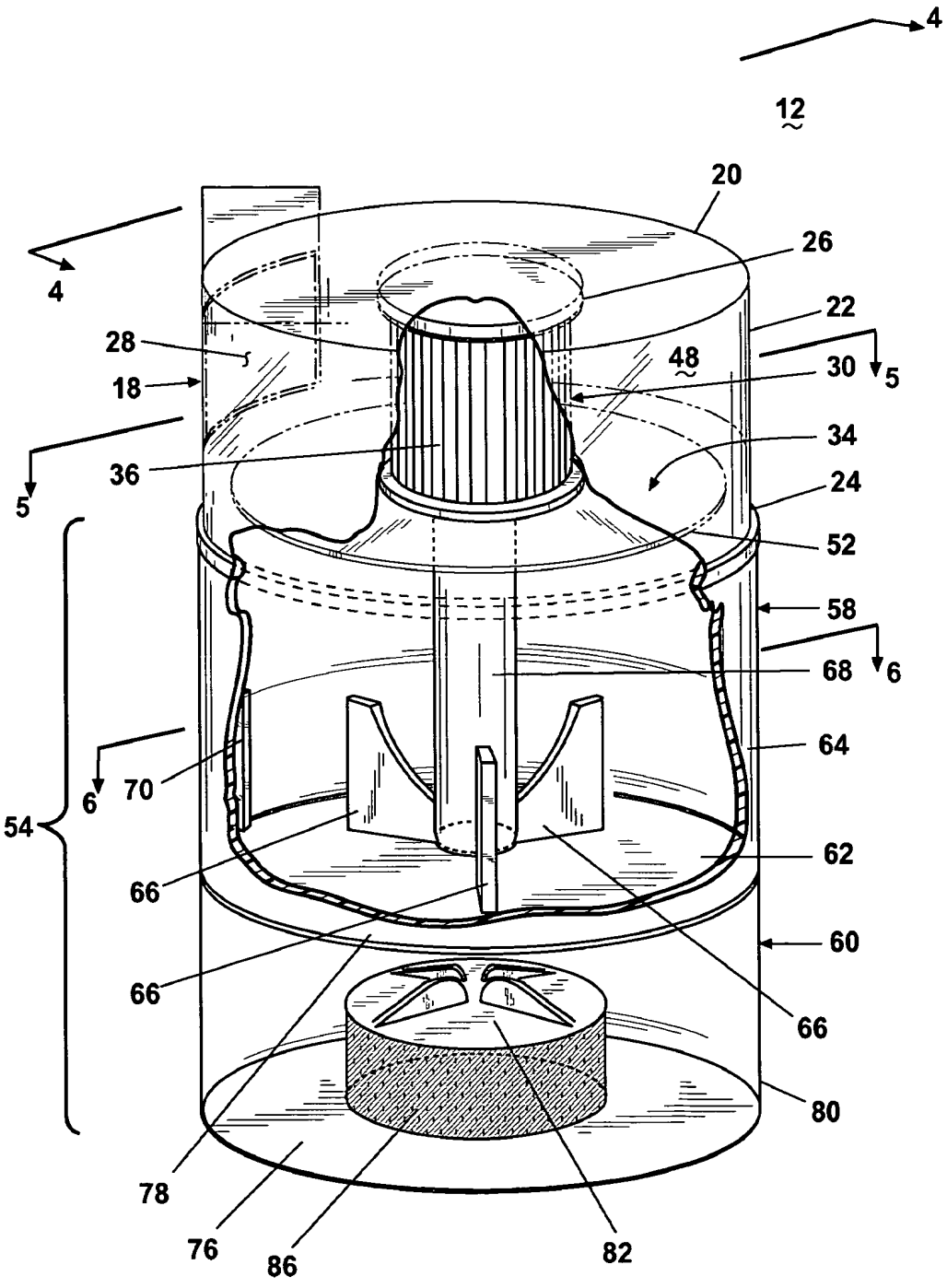
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Fig. 2

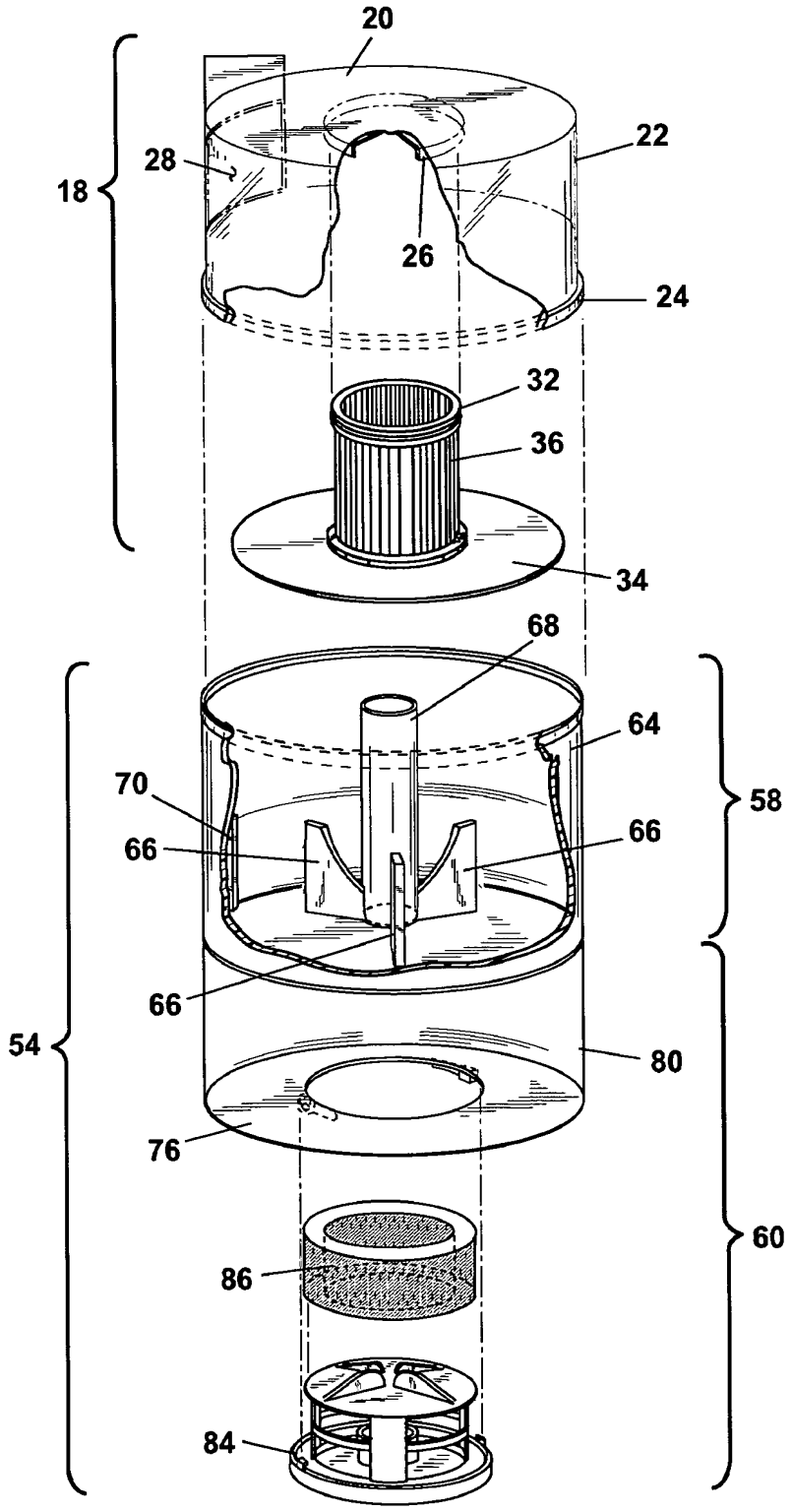

Fig. 3

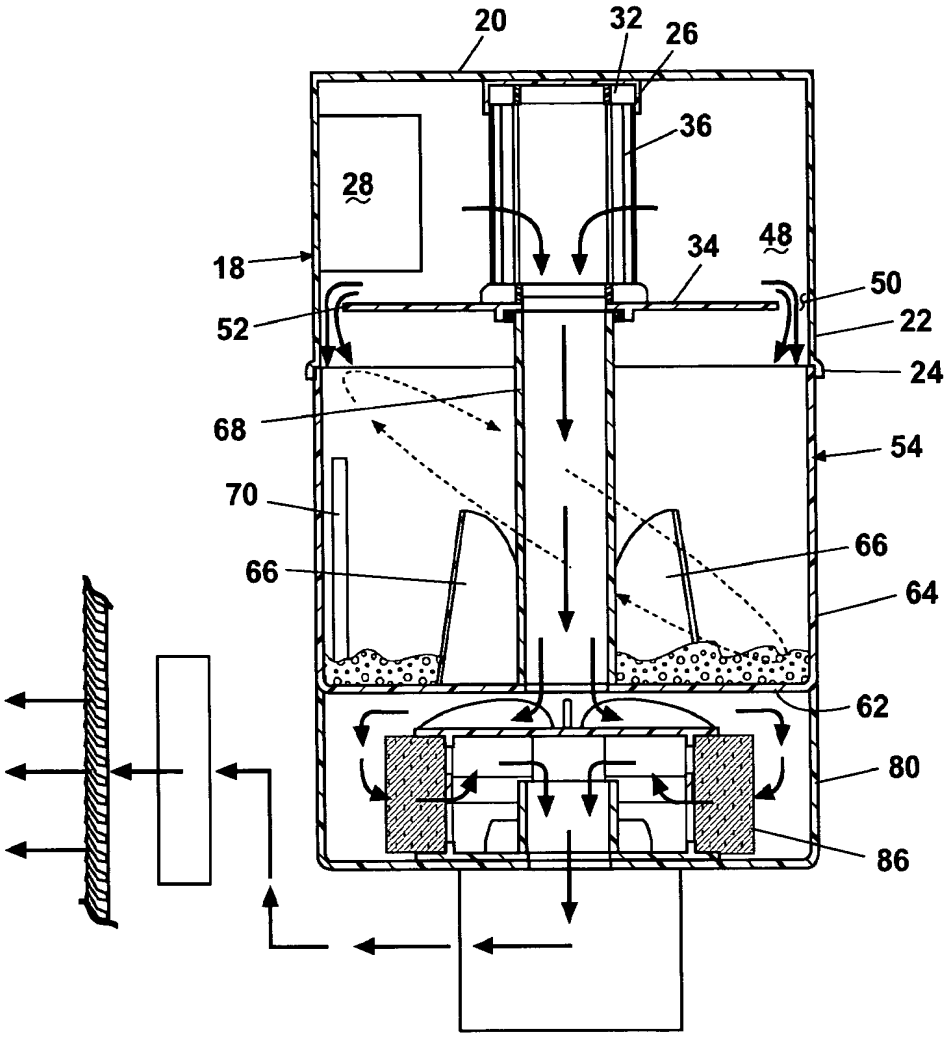

Fig. 4

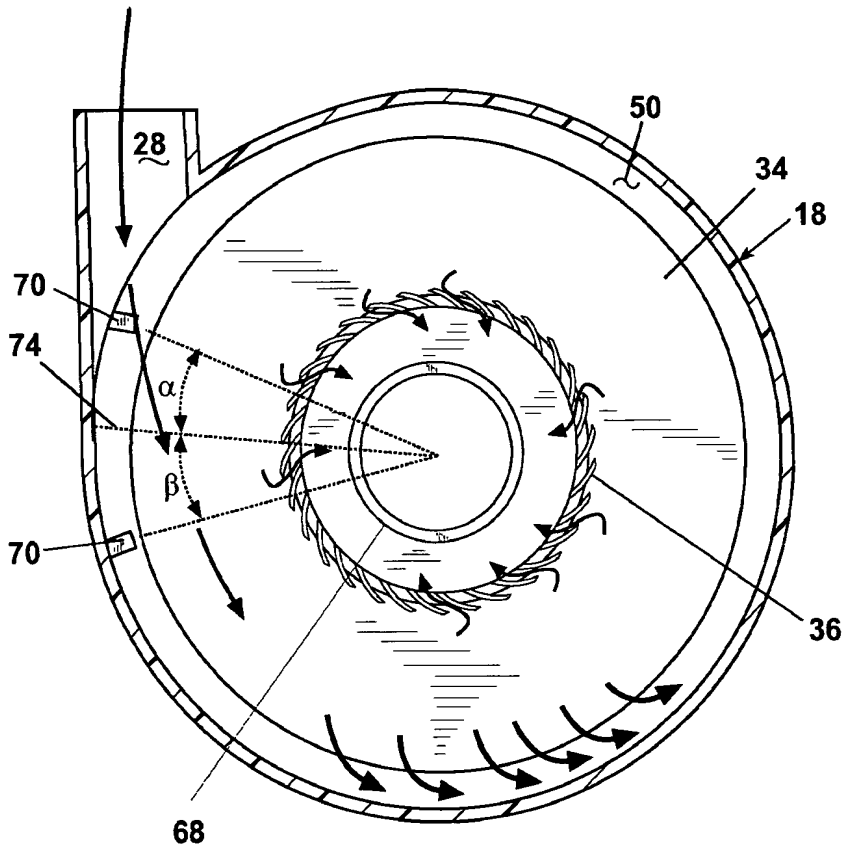

Fig. 5

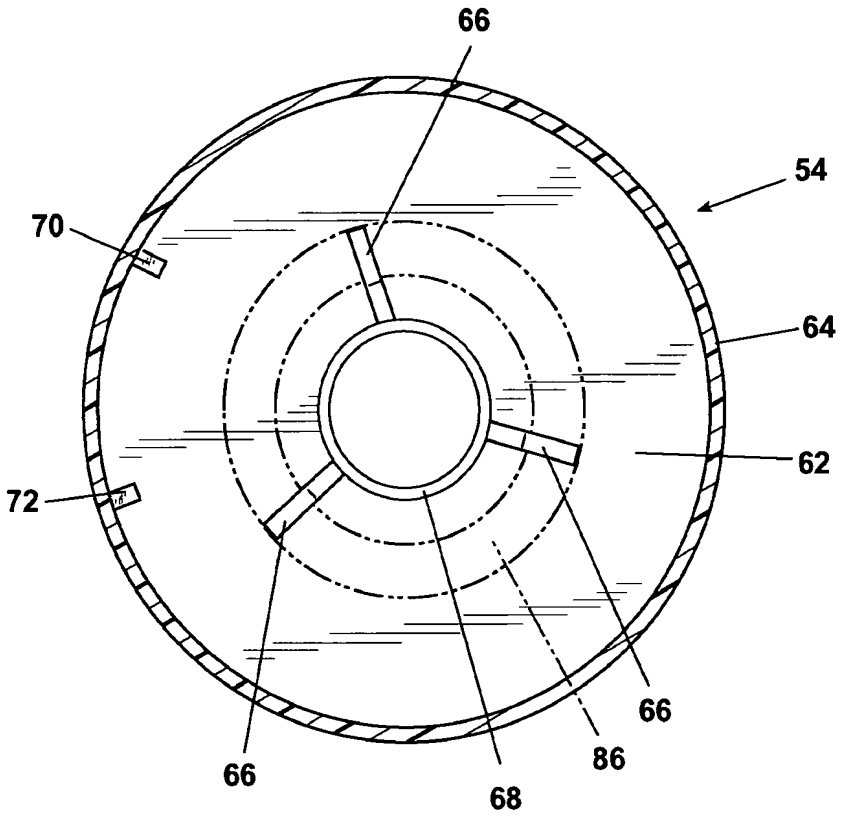

Fig. 6

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Document type: Certified copy of priority document

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